ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta

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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

RESEARCH REPORTS

These research reports describe the results of investigations funded under the Alberta Oil Sands Environmental Research Program, which was established by agreement between the Governments of Alberta and Canada in February 1975.

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Phone (403) 427-3943.

Life Cycles of Some Common Aquatic Insects
of the Athabasca River, Alberta

Project AF 2.2.1

AOSERP Report 11

LETTER OF TRANSMITTAL

The Hon. D. J. Russell
Minister of the Environment
Legislative Building
Edmonton, Alberta

and

The Hon. R. LeBlanc
Minister of Fisheries and the Environment
Parliament Buildings
Ottawa, Ontario.

Sirs:

Enclosed herein is the report on "Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta".

This report was prepared for the Aquatic Fauna Technical Research Committee of the Alberta Oil Sands Environmental Research Program, under the Alberta-Canada Agreement of 28 February 1975.

Respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
Deputy Minister, Alberta Environment

J. S. Tener, Ph.D.
Member, Steering Committee, AOSERP
Assistant Deputy Minister
Environmental Management Services
Environment Canada.

Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta

DESCRIPTIVE SUMMARY

ABSTRACT

Thirty artificial substrate samples taken over the open water period of 1975 in the Athabasca River at Fort McMurray, Alberta collected seven species of Plecoptera, seven of Ephemeroptera, and eight species of Tricoptera. Of these, the plecopterans Pteronarcys dorsata, Hastaperla brevis, Isoperla longiseta and Isogenus (I) frontalis colubrinus, the ephemeropterans Heptagenia (flavescens?), Rhithrogena sp. and Ephemerella (invaria and argo?), and the trichopterans Hydropsyche simulans, H. recurvata, H. slossanae and Cheumatopsyche sp. were present in sufficient numbers to permit estimates of life cycle lengths and emergence times to be made. In many cases, the life cycle patterns were interrupted in July and August. These interruptions are tentatively assigned to effects of blackfly control measures carried out some 450 km upstream.

BACKGROUND AND PERSPECTIVE

The purpose of this study was to provide AOSERP researchers with basic data on the occurrence and life cycles of aquatic insects inhabiting the Athabasca River near Fort McMurray, Alberta. The Aquatic Fauna Technical Research Committee cooperated by assisting in the continuation of studies, begun by the Alberta Blackfly Control Committee and the Freshwater Institute on the effects of Methoxychlor treatments to control blackfly larvae in the Athabasca River.

ASSESSMENT

This study will constitute part of the inventory program of aquatic species undertaken by the Aquatic Fauna Technical Research Committee. It will serve as a basic reference document for future research.

The report was reviewed by the Aquatic Fauna Technical Research Committee and the Oil Sands Environmental Study Group, and has been recommended for publication. The content of the report does not necessarily reflect the views of Alberta Environment, Fisheries and Environment Canada, or the Oil Sands Environmental Study Group. The mention of trade names of commercial

products does not constitute an endorsement or recommendation for use.

The Aquatic Fauna Technical Research Committee of the Alberta Oil Sands Environmental Research Program accepts this report, and thanks the researchers for their contributions.

Ron R. Wallace, Ph.D.
Chairman,
Aquatic Fauna Technical Research Committee.

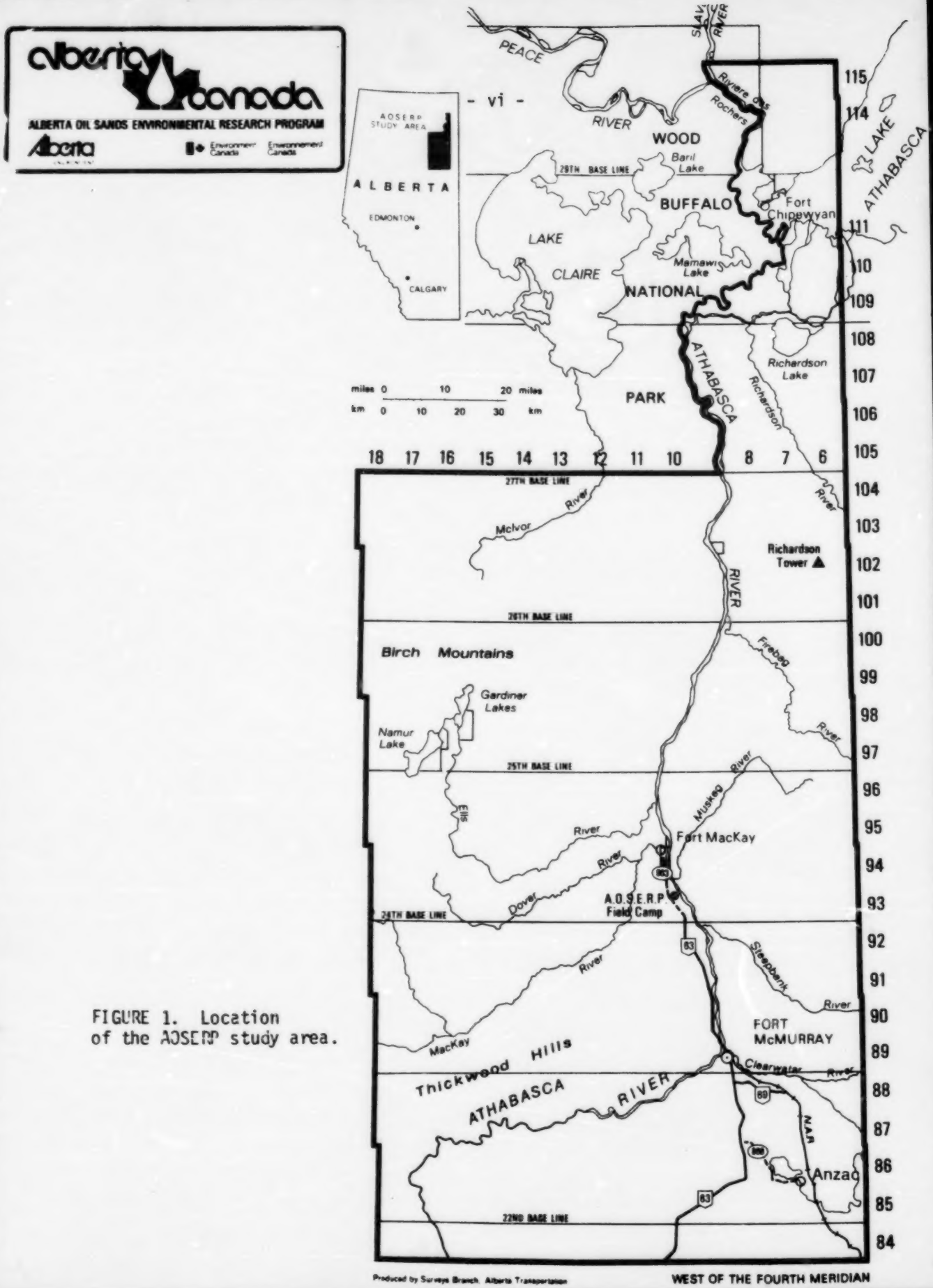

FIGURE 1. Location of the AOSERP study area.

LIFE CYCLES OF SOME COMMON AQUATIC INSECTS OF THE ATHBASCA RIVER, ALBERTA

by

JOHN F. FLANNAGAN

Fisheries and Environment Canada
Fisheries and Marine Service
Freshwater Institute
Winnipeg, Manitoba

for

AQUATIC FAUNA TECHNICAL RESEARCH COMMITTEE
ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

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ABSTRACT

Thirty artificial substrate samples taken over the open water period of 1975 in the Athabasca River at Fort McMurray, Alberta collected seven species of Plecoptera, seven of Ephemeroptera and eight of Tricoptera. Of these, the plecopteras Pteronarcys dorsata, Hastaperla brevis, Isoperla longiseta, and Isogenus (I) frontalis colubrinus; the ephemeropterans Heptagenia (flavescens?), Rhithrogena sp. and Ephemerella (invaria and argo?); and the trichopterans Hydropsyche simulans, H. recurvata, H. slossanae, and Cheumatopsyche sp. were present in sufficient numbers to permit estimates of life cycle lengths and emergence times to be made. In many cases, the life cycle patterns were interrupted in July and August. These interruptions are tentatively assigned to effects of blackfly control measures carried out some 450 km upstream.

INTRODUCTION

During the spring of 1975, the Alberta Blackfly Control Committee (ABCC) sponsored a second experimental treatment of the Athabasca River with methoxychlor as a blackfly control measure. This second treatment (carried out on June 4th) was at the same concentration as the first, namely 300 ppb, but the injection time was cut from 15 minutes to 7.5 minutes in an attempt to reduce both the distance and severity of the effect on non-target organisms.

A project designed to study the effects of this treatment on the non-target aquatic animals of the river was jointly financed by the ABCC and the Freshwater Institute, Winnipeg. This project included use of artificial substrates as a tool to measure the elimination and recolonization (if any) of the aquatic insect populations as a result of the methoxychlor treatment. The Aquatic Fauna Technical Research Committee of AOSERP felt that valuable information on the species composition and life cycles of the aquatic insect fauna of the Fort McMurray area could be obtained if the artificial substrate samples taken in this area, as part of the blackfly control program, were sorted to species or species groups, and therefore AOSERP provided money to hire Mrs. Laurie Tinker to perform this task.

The life cycles presented here almost invariably show interruptions on the July and August sampling dates. These interruptions have been tentatively attributed to the effects of the blackfly control measures upstream, but since the control samples taken above the methoxychlor injection point have not yet been analyzed, the possibility of some other causative agent must remain.

METHODS

Chicken barbeque baskets filled with 4-5 cm rocks and fitted with a nylon net which enveloped the basket before retrieval were used as artificial substrates. Some 30 of these samplers were retrieved after a minimum colonization time of at least three weeks. Since the project had initially been set up to measure the effects of a methoxychlor injection some 450 kilometers upstream, three sets of three samplers were lifted before the calculated arrival time of this chemical at Fort McMurray (one set in late May and two in the first week of June) and one set was lifted in each of the five days following the expected arrival date of the insecticide. One set was then lifted every two weeks for the remainder of the summer, except for the period at the beginning of July when the river was too high.

On retrieving the sampler all the rocks were scrubbed clean of animals and these together with the accumulated vegetation, silt, etc. were sieved clean in a 400μ mesh sieve and preserved in formol. The animals were then sorted and identified to species or genus, using Ross (1944) for the Trichoptera, Needham et al. (1935) and Burks (1953) for the Ephemeroptera and Edmondson (1966), Gaufin et al. (1972), Ricker (1964), Classen (1931), and Frison (1935, 1942) for the Plecoptera.

RESULTS AND DISCUSSION

The determination of life cycles of the species treated in this report is, in many cases, complicated (presumably) by the methoxychlor

treatment. In some cases age classes are missing or severely reduced in numbers for two months or more and in others it is difficult to judge when emergence of adults or hatching of eggs took place. However, in most cases, it is still possible to make an "educated guess" at the length and timing of these events.

Plecoptera:

Some 7 species of Plecoptera were sampled by the baskets. These were Acroneuria abnormis, Pteronarcys dorsata, Peltoperla sp., Hastaperla brevis, Isogenus (isogenoides) frontalis colubrinus, Isogenus expansus and Isoperla longiseta. Of these, 4 species were present in sufficient numbers to give some indications of the length of their life cycles and their emergence periods.

Of these Pteronarcys dorsata, a large supposedly herbivorous species, showed considerable variation in size between males and females (Fig. 1) and within each year class but does appear to have at least a three year life cycle. Since emergence occurs each year in early June three populations must be present. It appears from the results that during the first year these animals grew only a small amount since small animals were caught in May only shortly after break-up and before any adults were flying. Growth in the second year is considerably faster and by the end of this period the nymphs are 21-27 mm long. By May of their third year the nymphs are mature (41-48 mm long) and are ready to emerge.

Hastaperla brevis (Fig. 2) shows the strongest indication of being affected by the treatment since no specimens were captured after mid-June. However, a one year life cycle is clearly indicated with "young of the year"

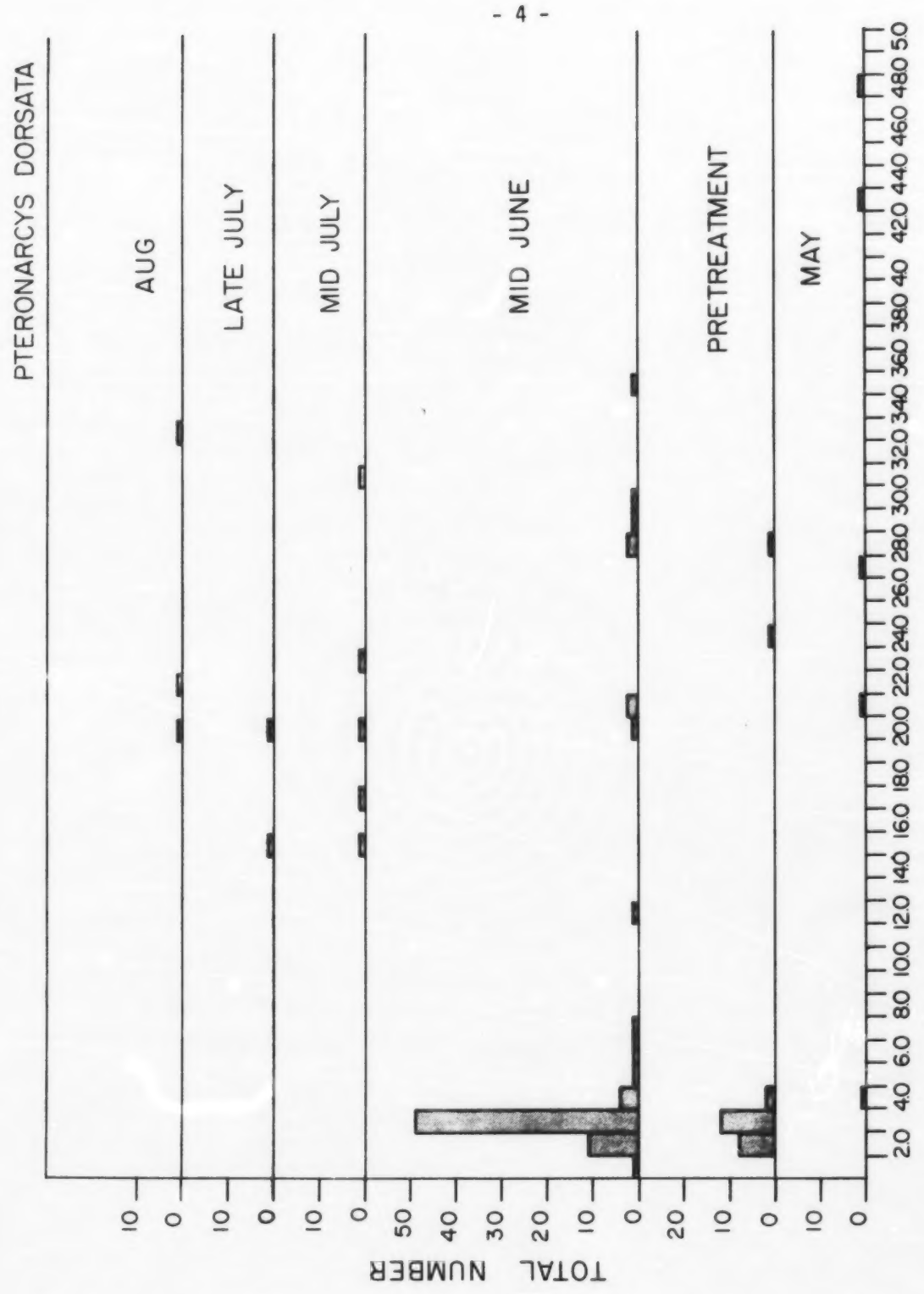

FIGURE 1. Size distributions of Pteronarcys dorsata throughout the summer, 1975.

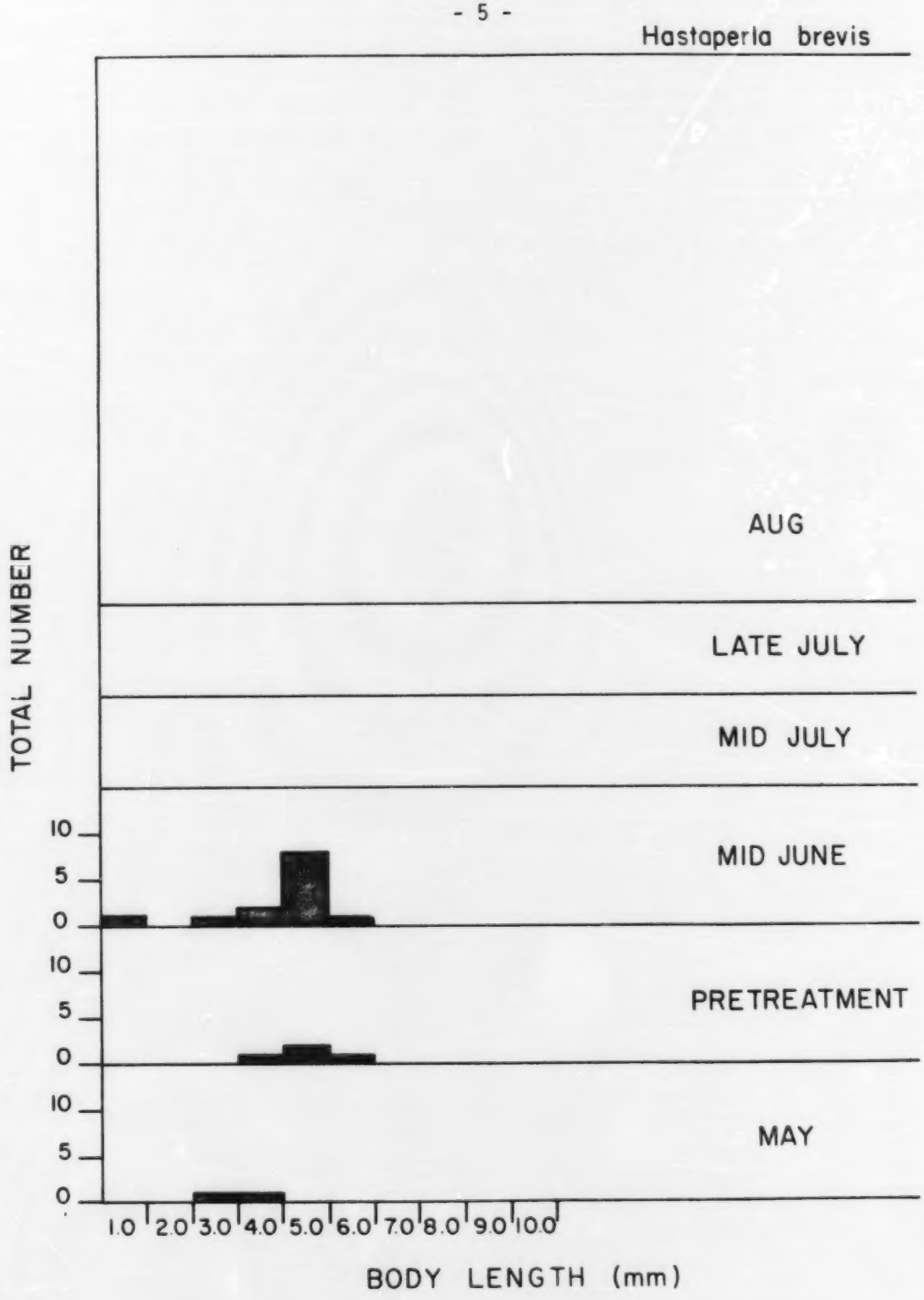

FIGURE 2. Size distributions of Hastaperla brevis throughout the summer, 1975.

appearing in mid-June samples, and mature nymphs being present by the early June pretreatment samples.

The Isoperla longiseta (Fig. 3) histogram is very difficult to interpret, since a wide range of size classes appears to be present throughout most of the summer, including very small specimens (1 mm early June to August). However, mature nymphs are present only in the June samples suggesting only one emergence period per summer. This, together with the absence of any obvious bimodality in the histogram, perhaps suggests a one or two year life cycle with an extended egg hatching period. Further research is required to more clearly elucidate the growth pattern of this species.

The fourth species Isogenus (I) frontalis colubrinus (Fig. 4) although showing considerable variation in nymphal size in the first three sets of samples, presumably related to the dispersity in size between male and female nymphs, clearly has a one year life cycle with emergence in June and considerable growth having already taken place by late July. Absence or low numbers of specimens in mid and late summer again indicates a serious disturbance to the habitat at this time.

Ephemeroptera:

At least seven species of this order were collected in the Fort McMurray area: Rhithrogena sp., Heptagenia (flavescens?), Ametropus neavei, Baetis sp., Ephemerella (Invaria and Argo?) and Hexagenia limbata. Four of these species appeared to occur in sufficient numbers to provide information on growth and emergence.

Heptagenia (flavescens?) (Fig. 5) appears to have a simple one year life cycle with emergence in late May and June and young nymphs appearing

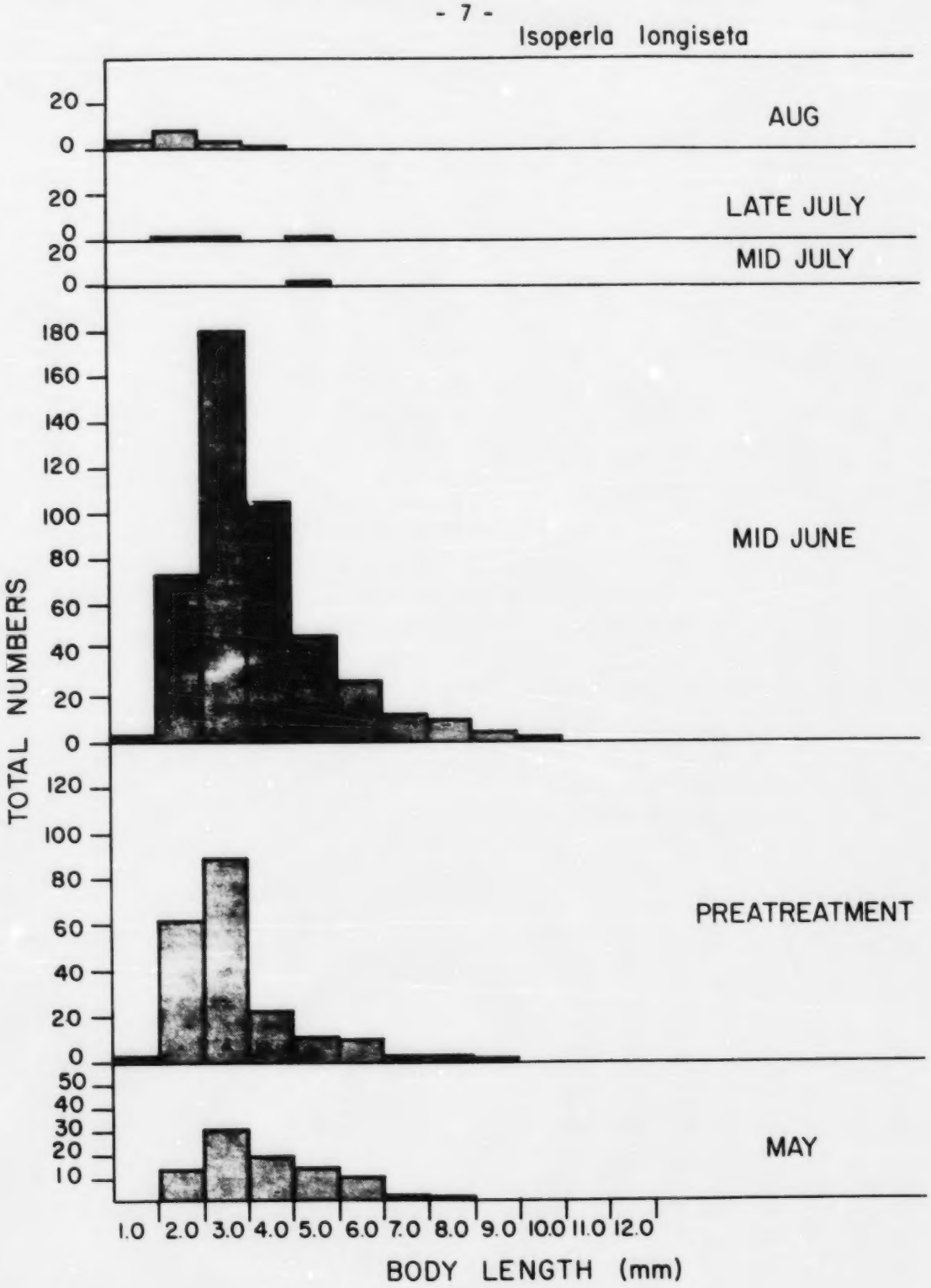

FIGURE 3. Size distributions of Isoperla longiseta throughout the summer, 1975.

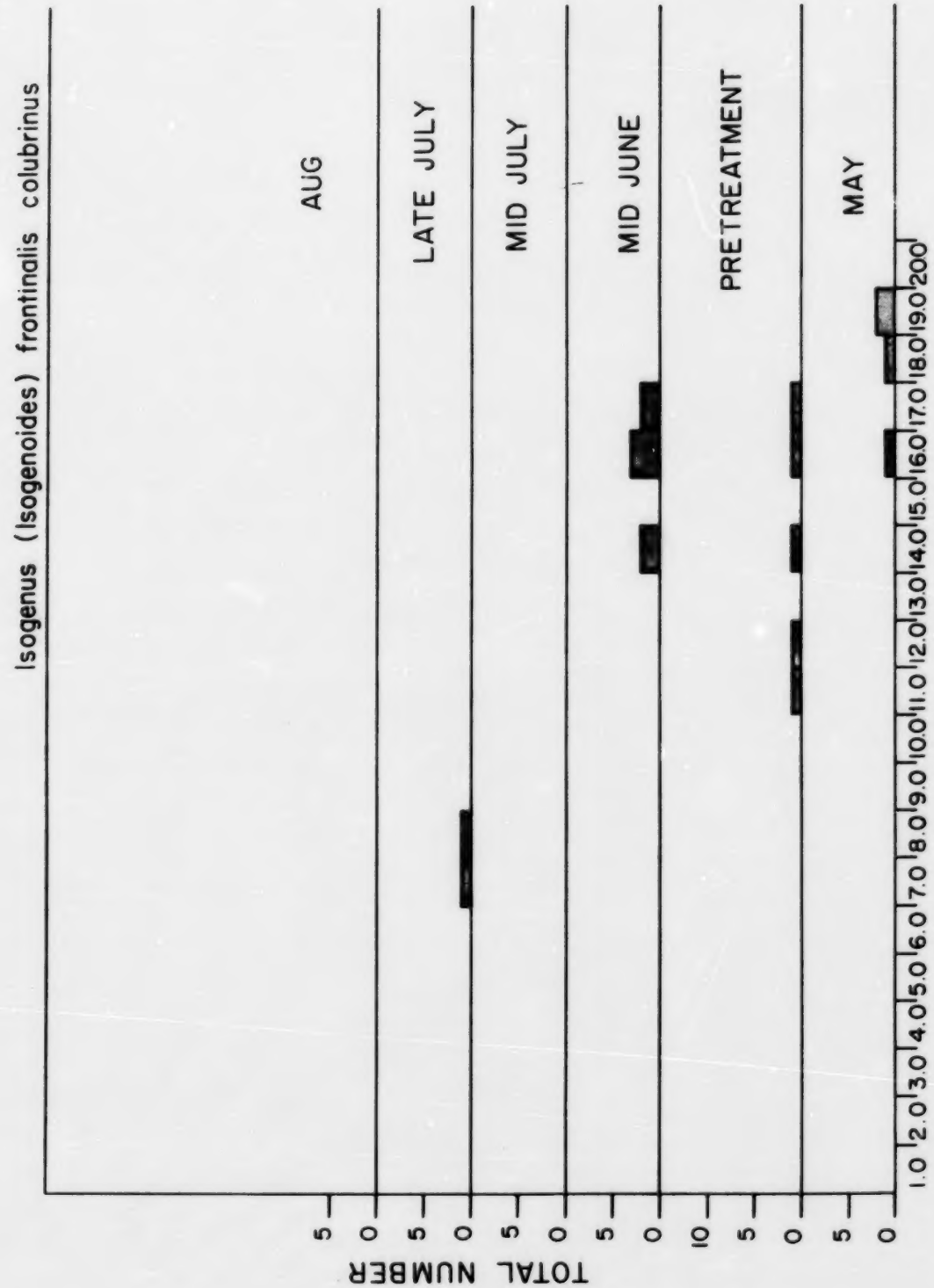

FIGURE 4. Size distributions of Isogenus (I) frontalis colubrinus throughout the summer, 1975.

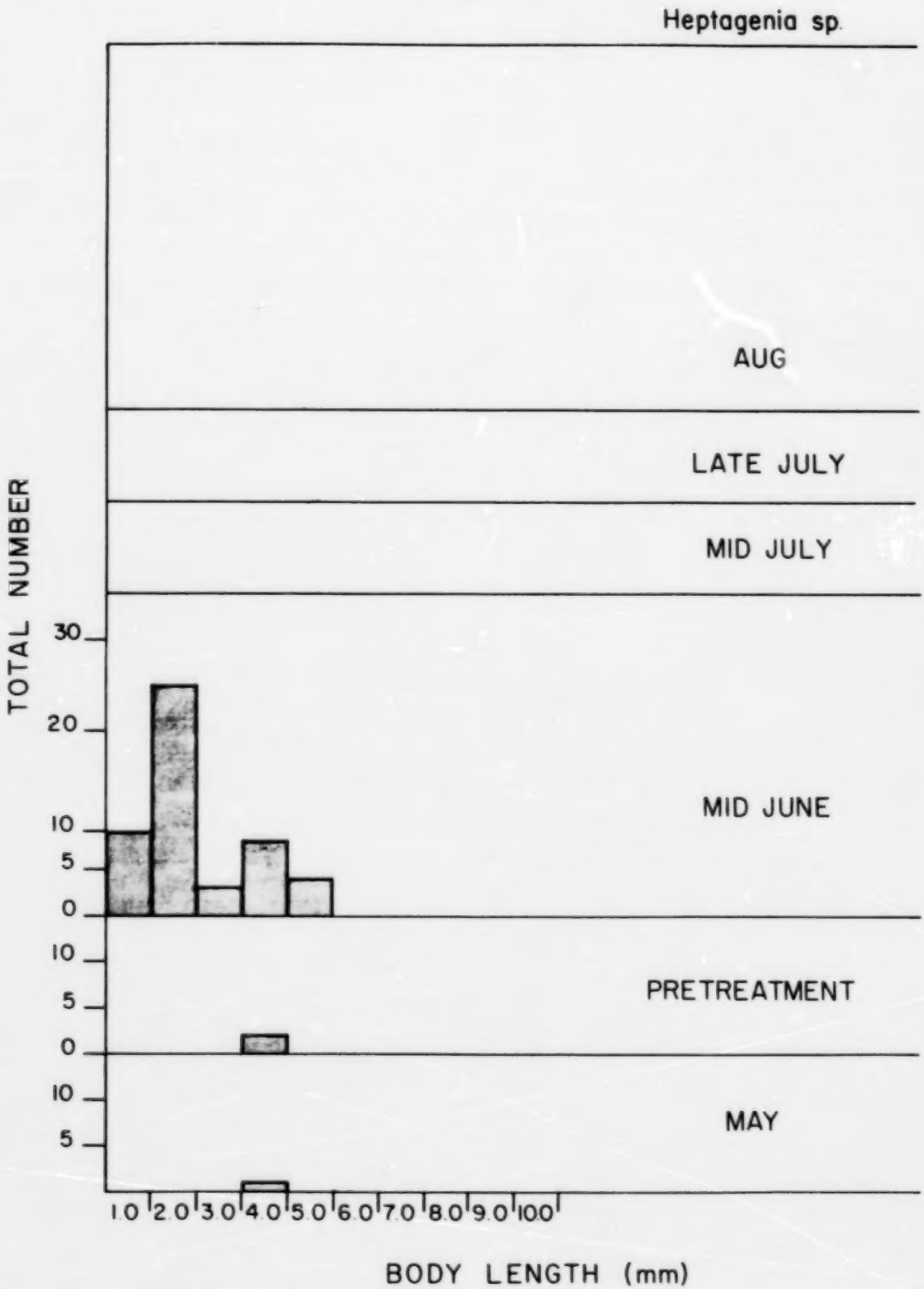

FIGURE 5. Size distributions of Heptagenia (flavescens?) throughout the summer, 1975.

by mid-June.

Rhithrogena sp. (Fig. 6) appears to show some bimodality especially in the August samples indicating either a double emergence period or two species. The appearance of very young nymphs also appears to be bimodal. Whether a bivoltine species or two species are present can only be decided by rearing nymphal specimens through to adults since the nymphs of this genus are generally not identifiable to species. It is also worthy of note that this is one of the few genera in which no obvious population decline occurs in mid-late summer.

Ephemerella (Invaria and Argo?) (Fig. 7). These two species are very similar in colour pattern, etc., being separated by Burks (1953) by the sinuate margin of the eight tergite. Mature nymphs both with and without the margin of the eight tergite sinuate were found in these samples. The smaller nymphs, however, could not be separated - thus the histogram shows length frequencies for the genus as a whole. A decided bimodality is obvious, indicating a simple one year life cycle for both species. In Illinois, E. invaria emerges later than E. argo (Burks, 1953) although both emerge in spring. In the Athabasca River both species probably emerge in the summer.

Trichoptera:

Cheumatopsyche sp., Hydropsyche recurvata, H. slossonae, H. simulans, Lepidostoma sp., Glossosoma sp., Neureclepsis sp., and Glyphopsyche sp. were recorded from the Athabasca R. Fort McMurray station.

Hydropsyche simulans (Fig. 8) was present in only very small numbers but these seem to indicate a simple one year life cycle with emergence in June and most of the growth in late summer, winter or early spring.

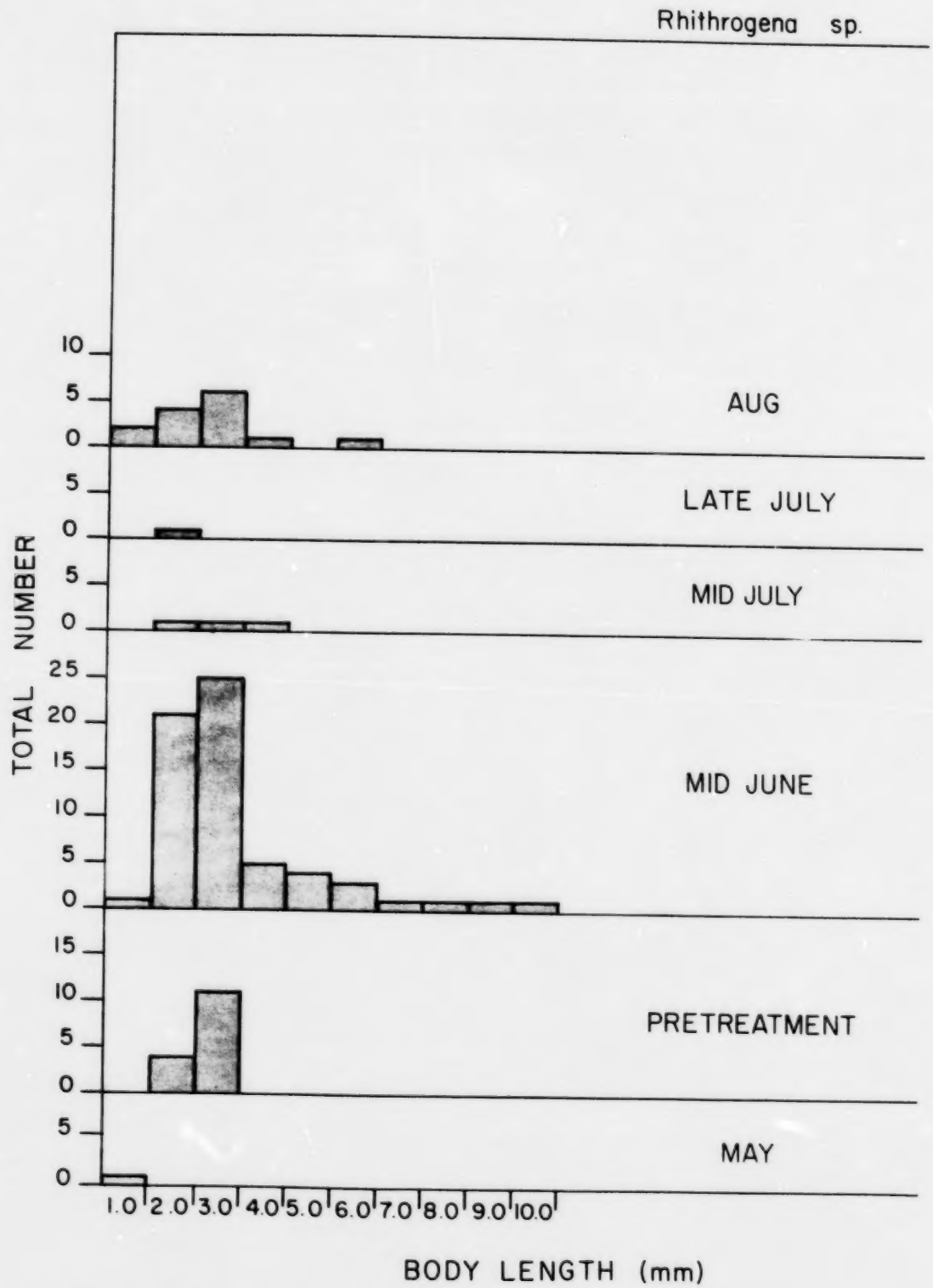

FIGURE 6. Size distributions of Rhithrogena sp. throughout the summer, 1975.

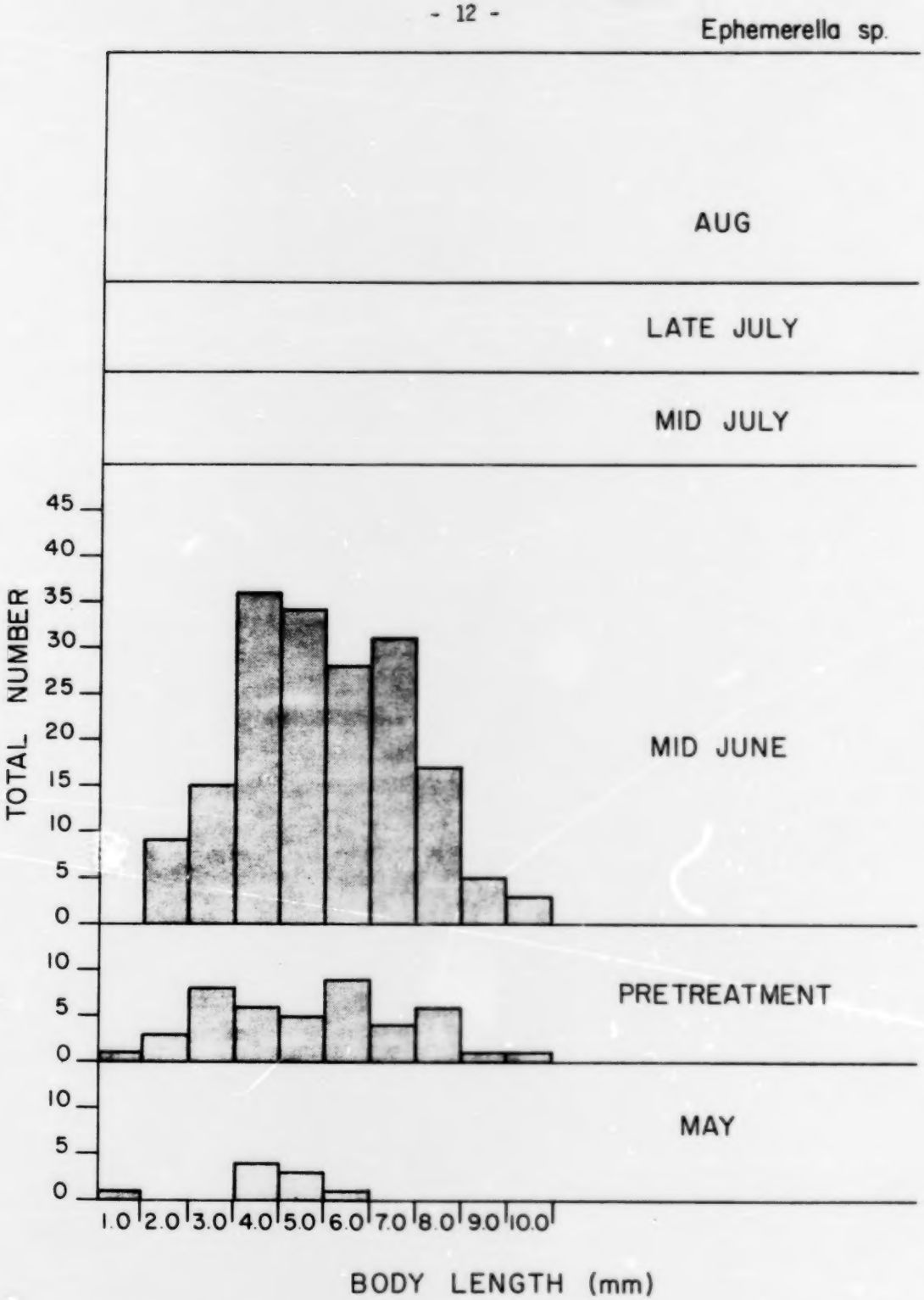

FIGURE 7. Size distributions of Ephemerella invaris and E. argo? throughout the summer, 1975.

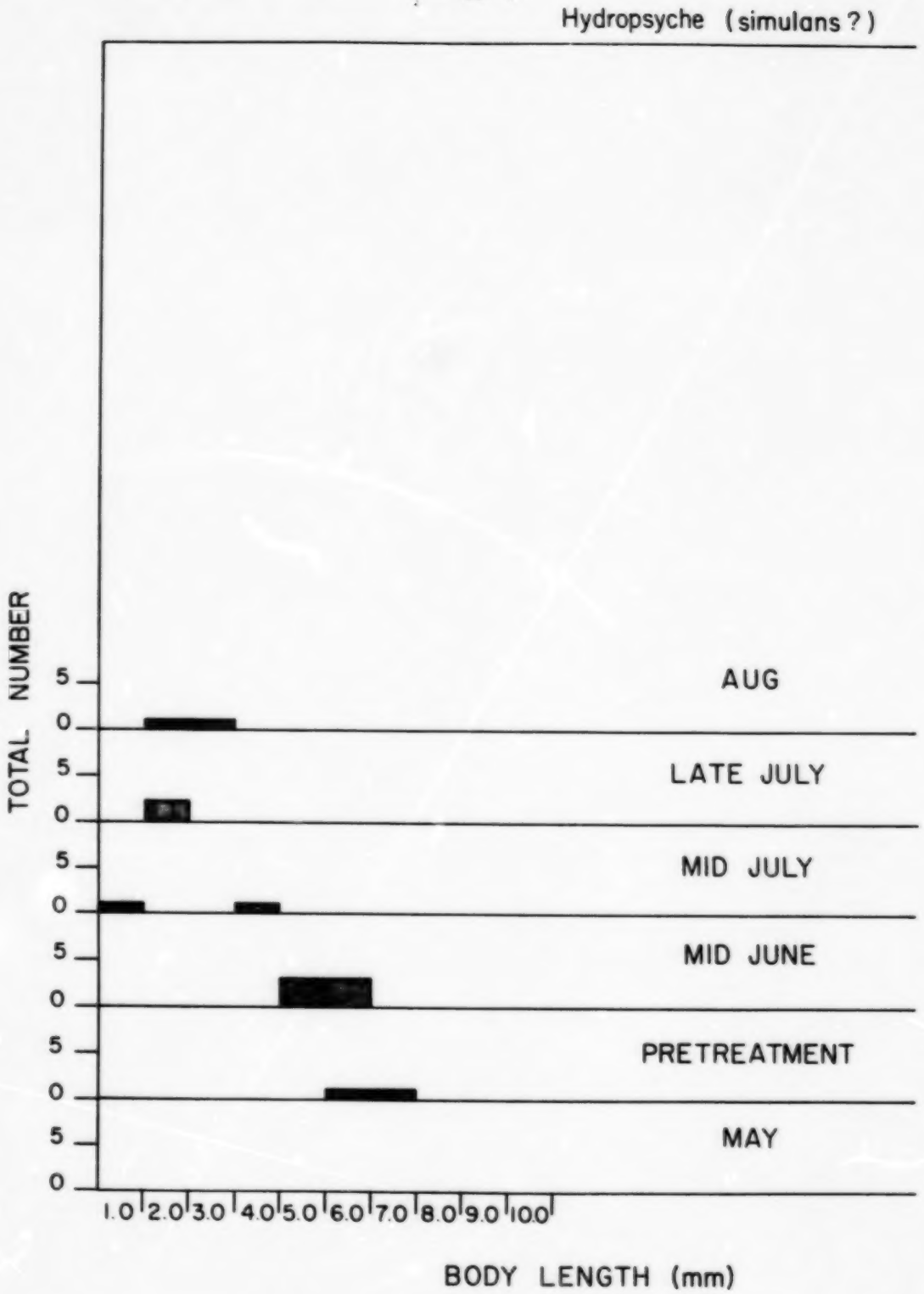

FIGURE 8. Size distributions of Hydropsyche simulans throughout the summer, 1975.

The Cheumatopsyche sp. histogram (Fig. 9) is a little more complex with very young specimens (1 mm) appearing both in early June (pretreatment) and August samples. The total lack of specimens in the two sets of July samples makes the figure hard to interpret but it is probable that we are again dealing with either two species or with one bivoltine species and again only reared material will solve this problem since the larvae of the genus are not separable to species.

Without the growth data for mid and late July it is almost impossible to determine the life cycle of Lepidostoma (Fig. 10). Very small animals are present in both May and mid-June samples indicating, perhaps, that the species can complete its life cycle in a month and that emergence occurs in June. If growth at this rate can continue throughout the summer this species is probably multivoltine.

The last two species to be discussed, Hydropsyche recurvata and H. slossonae (Fig. 11) are presented together because the young larvae are difficult to separate to species. Analyses of the mature larvae indicated two flight periods for H. slossonae, the first in early spring and the second between the June 13 and the July 31 sample dates, and one for H. recurvata. Length was plotted against cumulative number because it often shows size classes more distinctly than size distribution histograms. In Figure 11, four size classes are evident on the May sampling date. If a one year life cycle occurs in the two populations of H. slossonae and the one of H. recurvata, the smallest size class should be recently hatched, the next size class larger should be half grown, the largest size class should be late emerging H. slossonae, and the remaining size class should be H. recurvata. It is then possible to follow the size groups through their life

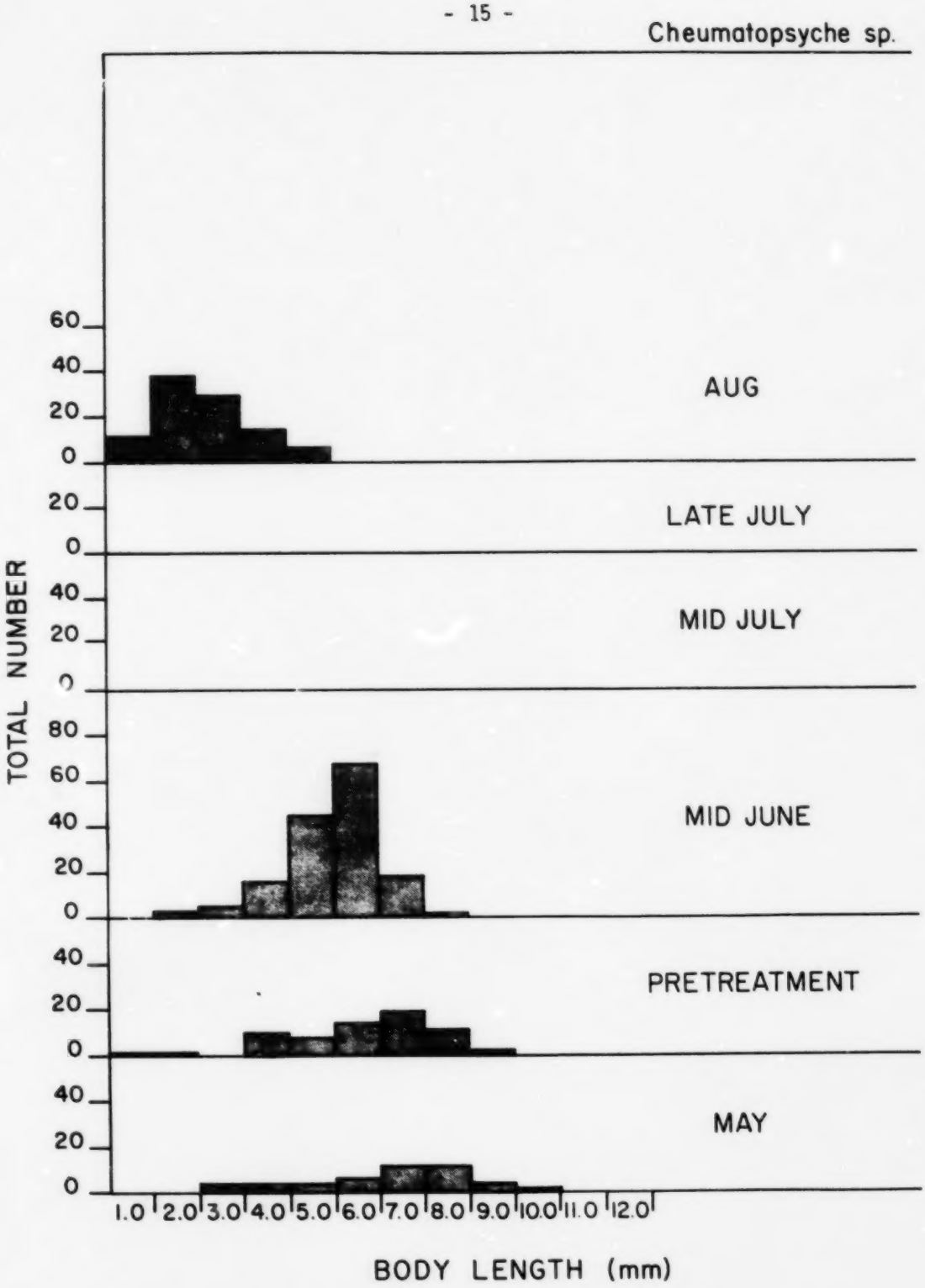

FIGURE 9. Size distributions of Cheumatopsyche sp. throughout the summer, 1975.

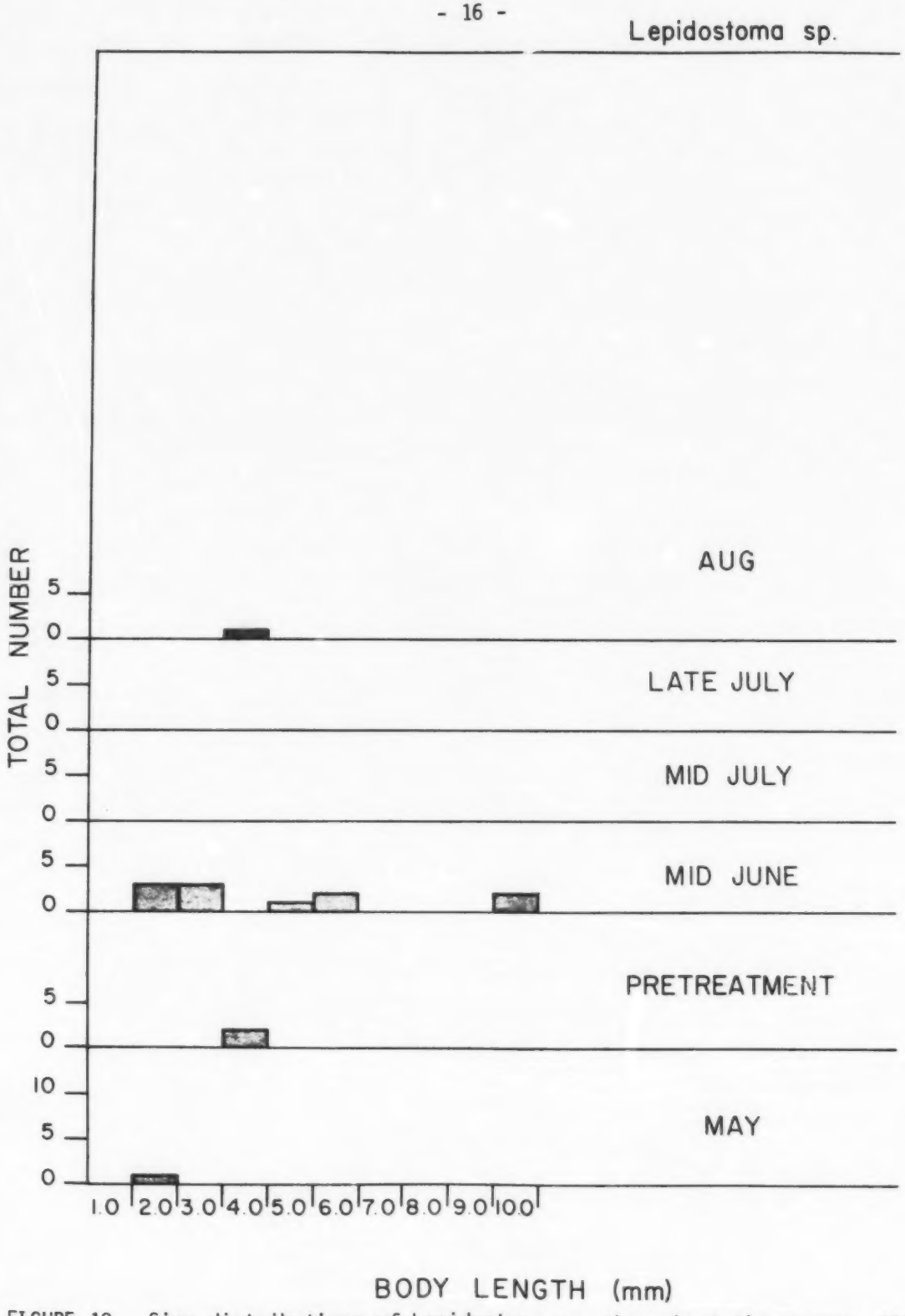

FIGURE 10. Size distributions of Lepidostoma sp. throughout the summer, 1975.

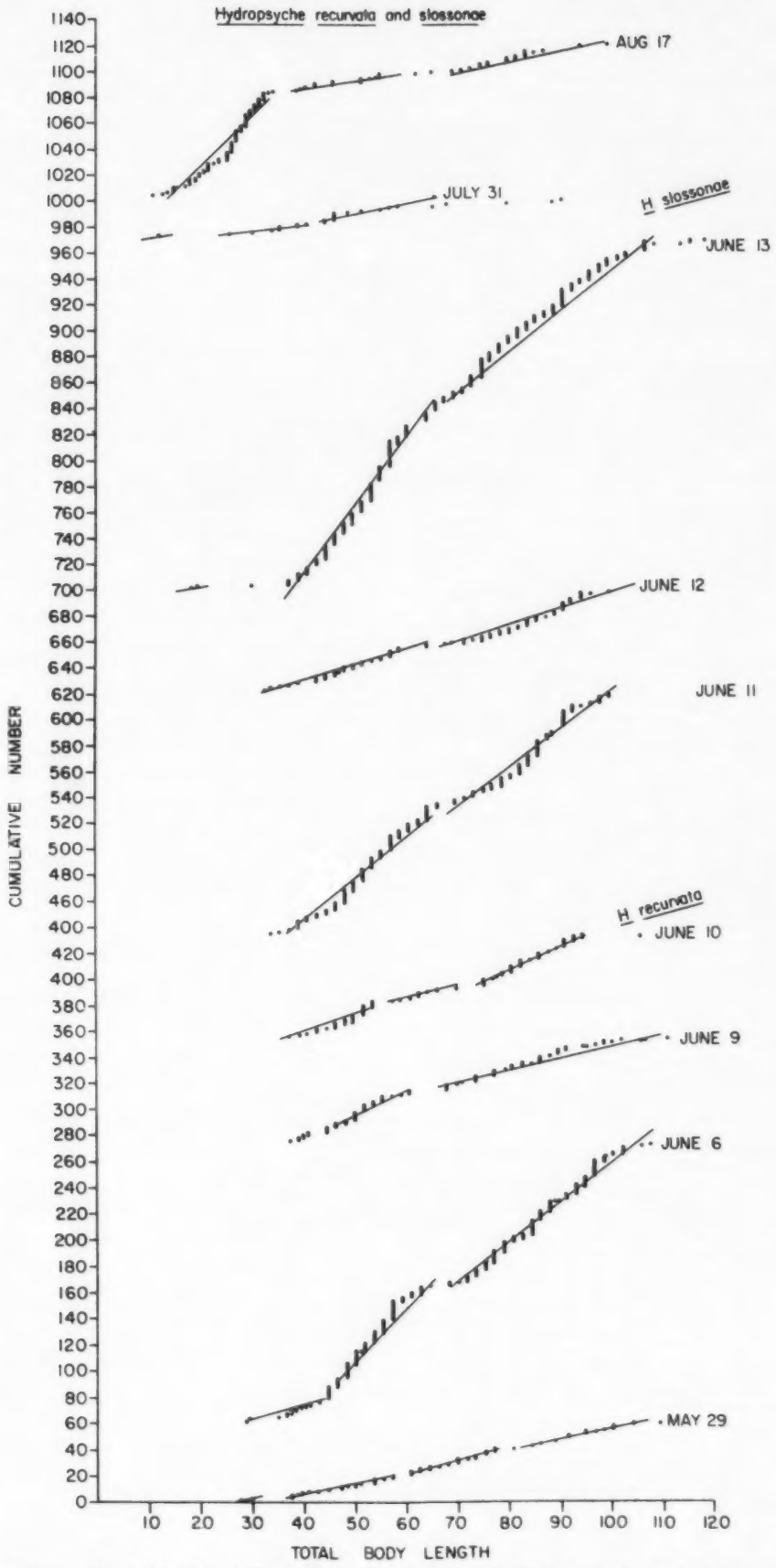

FIGURE 11. Size distributions of Hydropsyche recurvata and H. slossonae throughout the summer, 1975.

cycles - the four size groups being reduced to three as the remaining H. slossonae emerge, then to two as H. recurvata emerges, back to three classes as the H. recurvata eggs hatch and so on. Other possible explanations of the size distribution are possible but these require either longer life cycles or more emergence periods for one or both of the species involved. Further collections to fill in the gap between June 13 and July 31 should elucidate more positively the life cycles of these two species.

CONCLUSIONS

With the exception of Rhithrogena sp. all the stoneflies and mayflies appear to have suffered major population crashes in July and August. If these crashes were due to the blackfly control measures, it is possible that the species sensitive to this insecticide are likely to be sensitive to other pollutants. Forms such as Pteronarcys dorsata which have a long life cycle are also particularly susceptible to environmental change or damage since they have to survive all of the changes which occur in a three or four year time period.

Many of the results presented here are rather tentative since the project was not designated to elucidate life histories - nevertheless it is a start to a study which must be continued if a real understanding of the effects of pollutants on aquatic ecosystems is to be achieved.

ACKNOWLEDGEMENTS

Besides the financial acknowledgements listed in the Introduction, I would like to thank Mrs. L. Tinker for her valiant efforts in sorting and measuring the animals, Mr. Don Cobb for preparing the figures and Mr. B.E. Townsend for allowing me to use his methoxychlor assessment samples.

REFERENCES

BURKS, B.O. 1953. The mayflies, or Ephemeroptera, of Illinois. Bull. Illinois Nat. Hist. Surv. 26(1): 1-216.

CLAASSEN, P.W. 1931. Plecoptera nymphs of America (north of Mexico). Thos. Say Foundation of the Entomol. Soc. Am. Publ., No. 3: 1-199.

EDMONDSON, W.T. 1966. Freshwater Biology by H.B. Ward and G.C. Whipple. 2nd edit. J. Wiley & Sons, New York.

FRISON, T.H. 1935. The stoneflies, or Plecoptera, of Illinois. Bull. Illinois Nat. Hist. Surv. 20: 281-471.

_____ 1942. Studies of North American Plecoptera, with special reference to the Fauna of Illinois. Bull. Illinois Nat. Hist. Surv. 22: 231-355.

GAUFIN, A.R., W.E. RICKER, M. MINER, P. MILAM and R.A. HAYS, 1972. The stoneflies (Plecoptera) of Montana. Trans. Amer. Ent. Soc. 98 (1): 1-161.

NEEDHAM, J.G., J.R. TRAVERS and YIN-CHI HSU, 1935. The biology of mayflies. Comstock, Ithaca, New York.

RICKER, W.E. 1964. Distribution of Canadian stoneflies. Gewasser and Abwasser, Heft 34/35, S. 50-71. 1 Verh. 3 Int. Symp. Plecopteren (1964) Bagel. Dusseldorf.

ROSS, H.H. 1944. The caddisflies or Trichoptera of Illinois. Bull. Illinois Nat. Hist. Surv., 23: 1-326.